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List of Acronyms

<	less than
>	greater than
°C	degrees Celsius
°F	degrees Fahrenheit
ABA	acid-base accounting
AGP	acid generating potential
aka	also known as
Al	aluminum
ANFO	ammonium nitrate/fuel oil
ANOVA	analyses of variance
ANP	acid neutralizing potential
APHA	American Public Health Association
ARD	acid rock drainage
AST	aboveground storage tank
ASTM	American Society for Testing and Materials
ATSDR	Agency for Toxic Substances and Diseases Registry
AVS/SEM	acid volatile sulfides/simultaneously extracted metals
Ba	barium
BAF	bioaccumulation factor
BERA	Baseline Ecological Risk Assessment
BLM	Bureau of Land Management
BOD	biological oxygen demand
C&A	Chadwick & Associates, Inc.
Ca	calcium
CCR	California Code of Regulations
CEC	Chadwick Ecological Consultants, Inc.
cfs	cubic feet per second
Cl	chloride
CLP	Contract Laboratory Program

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cm	centimeter(s)
COC	chain of custody
COD	chemical oxygen demand
COPC	chemical of potential concern
CV	coefficient of variation
DBSM	Database Management System
DCM	DCM Science Laboratory, Inc.
DO	dissolved oxygen
DOC	dissolved organic carbon
DP	discharge permit
DRC	dynamic reaction cell
DRO	diesel range organics
DVR	data validation report
EA	exposure area
EBAM	Environmental Beta Attenuation Monitor
EDD	electronic data deliverables
EEA	ecological exposure area
Eh	reduction-oxidation potential
EPA	U.S. Environmental Protection Agency
EPT taxa	Ephemeroptera, Plecoptera, Trichoptera
ESI	EnviroSystems, Incorporated
ET	evapotranspiration
ETO taxa	Ephemeroptera, Trichoptera, Odonates
F	fluoride
FA	Factor Analysis
Fe	iron
FEM	federal equivalent method
FGS	Frontier Geosciences, Inc.
FLT	field leachate test

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FRM	federal reference method
FS	Feasibility Study
FSP	Field Sampling Plan
Golder	Golder Associates, Inc.
g/L	grams per liter
gpm	gallons per minute
GPS	Global Positioning System
GRO	gasoline range organics
GSI	groundwater/surface water interaction
GWQB	Ground Water Quality Bureau
^{2}H	stable isotope of hydrogen (or deuterium)
HCl	hydrochloric acid
HCT	humidity cell test
HDPE	high-density polyethylene
HF	hydrofluoric
HH	Human Health
HNO_3	nitric acid
HRSR	high-resolution seismic reflection
Hz	hertz
IC_{25}	inhibition (of growth) concentration at 25%
ICP	inductively coupled plasma
IDL	instrument detection limit
IDW	investigation-derived waste
ISCO	International Soil Conservation Organization
ISE	ion-selective electrode
K	potassium
km	kilometer
L/min	liter per minute
lbs/day	pounds per day

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List of Acronyms

LC_{50}	50% lethal concentration
LMWL	local meteoric water line
M&E	maintenance and electrical
m	meter
µg/m	micrograms per meter
µL	microliter
µm	micrometer(s)
µS/cm	microSiemens per centimeter
meq/L	milliequivalents per liter
mg	milligram
ml	milliliter
mm	millimeter
mv	millivolt
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
MAP	mean annual precipitation
MAY	mean annual yield
MDL	method detection level
MECS	Mining Environmental Compliance Section
MMD	Mining and Minerals Division
Mg	magnesium
Mn	manganese
Mo	molybdenum
MoS_2	molybdenite
mph	miles per hour
MS/MSD	matrix spike/matrix spike duplicate
Na	sodium
NAAQS	National Ambient Air Quality Standards
NaCl	sodium chloride

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List of Acronyms

NANP	net acid neutralization potential
NASC	North American Shale Composite
NMAC	New Mexico Administrative Code
NMAQB	New Mexico Air Quality Bureau
NMDA	New Mexico Department of Agriculture
NMDGF	New Mexico Department of Game and Fish
NMED	New Mexico Environment Department
NNP	net neutralization potential
NOAEL	no observed adverse effect level
NOEC	no observed effects concentration
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
NTU	nephelometric turbidity unit
^{18}O	stable isotopes of oxygen
PAG	potentially acid generating
PAH	polynuclear aromatic hydrocarbon
PCA	Principal Components Analysis
PCB	polychlorinated biphenyls
PCDDs	polychlorinated dibenzo-p-dioxins
PCDFs	polychlorinated dibenzofurans
pdf	portable document format
pCi/L	pico Curies per liter
PID	photoionization detector
PHREEQC (version 2)	PHREEQC version 2 – computer program for simulating chemical reactions and transport processes in natural or polluted water
PHREEQE	pH redox equilibrium equations
PHREEQCI	USGS-developed computer code based on Fortran program PHREEQE
PM_{10}	particulate matter 10 microns in size or smaller
PMSD	percent minimum significant difference

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List of Acronyms

PSCR	Preliminary Site Characterization Report
psi	pounds per square inch
PST	petroleum storage tank
PVC	polyvinyl chloride
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
RBC	risk-based concentration
redox	oxidation-reduction
RGC	Robertson GeoConsultants Inc.
RI	Remedial Investigation
RL	Reporting Limit
RPD	relative percent difference
SAP	Sampling and Analysis Plan
SAR	sodium adsorption ratio
SC	specific conductance
SE	standard error
Si	silica
SI	Slope Inclinometer
SIS	Seepage Interception System
SLC	Screening Level Criteria
SMA	Souder, Miller & Associates
SOP	Standard Operating Procedure
SPLP	Synthetic Precipitation Leaching Procedure
SPRI	South Pass Resources, Inc.
SRK	SRK Consulting
STL	Severn Trent Laboratories
SU	standard unit
SVL	SVL Laboratories

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SVOC	semivolatile organic compound
t/kt	tons per kiloton (of rock)
TAL	target analyte list
TDS	total dissolved solids
TKN	total Kjeldahl nitrogen
TMDL	total maximum daily load
TOC	total organic carbon
TPH	total petroleum hydrocarbons
TRV	toxicity reference value
TSN	Taxonomic Serial Number
TSS	total suspended solids
UPL	Upper Prediction Limit
URS	URS Corporation
USDA	U.S. Department of Agriculture
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U. S. Geological Survey
UST	underground storage tank
UTL	Upper Tolerance Limit
VOA	volatile organic analysis
VOC	volatile organic compound
WDC	WDC Exploration and Wells
WIS	Wildlife Impact Study
WQCC	New Mexico Water Quality Control Commission
WRCC	Western Regional Climate Center
XRD	x-ray diffraction
YOY	young-of-the-year
YCT	yeast-Cerophyl-trout chow
Zn	zinc

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English measurement	*Metric measurement (SI units)*
Length	
inches	2.54 E+01 millimeters (mm)
inches	2.54 centimeter (cm)
inches	2.54 E-02 meters (m)
feet	3.05 E+01 cm
feet	3.05 E-01 m
feet	3.05 E-04 kilometers (km)
yards	9.14 E+01 cm
yards	9.14 E-01 m
yards	9.14 E-04 km
mile (statute) (5,280 feet)	1.61 E+03 m
mile (statute) (5,280 feet)	1.61 km
Speed	
miles per hour	1.61 km/hour
Area	
square feet	9.29 E+02 square cm
square feet	9.29 E-02 square m
square yards	8.36 E-01 square m
square mile	2.59 square km
acres	4.05 E+03 square m
acres	4.05 E-03 square km
Volume	
acre-feet	1.23 E+03 cubic m
cubic feet	2.83 E+04 cubic cm
cubic feet	2.83 E-02 cubic m
gallons	3.79 liters
Mass	
ounce	28.3 grams
pound (16 ounces)	4.54 E-01 kilograms (kg)
ton (short = 2,000 pounds)	9.07 E+02 kg
ton (long = 2,240 pounds)	1.02 E+03 kg
ton (metric = 2,205 pounds)	1 E+03 kg

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TABLE OF CONVERSION FACTORS	
English measurement	*Metric measurement (SI units)*
Pressure	
pounds/square inch	6.89 E+03 pascal (Pa)
pounds/square inch	6.89 kilopascal (kPa)
Flow Rate	
cubic feet/second (cfs)	2.83 E-02 cubic meters/second
cubic feet/minute (cfm)	2.83 E+04 cubic cm/minute
gallons/minute (gpm)	3.79 liters/minute
gallons/day (gpd)	3.79 liters/day
Loading	
pounds/day (lbs/day)	4.54 E-01 kg/day
Hydraulic Units	
hydraulic conductivity (ft/day)	3.05 E-01 m/day
hydraulic conductivity (ft/day)	3.53 E-04 cm/s
transmissivity (ft^2/day)	9.29 E-02 m^2/day
transmissivity (gpd/ft)	1.24 E-02 m^2/day
Temperature	
temperature (°F)	(°F -32)/1.8 = °C

Signature Page

To the best of my knowledge, after thorough investigation, I certify that the information contained in or accompanying this submission is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Anne Wagner, Ph.D.
Project Coordinator

Executive Summary

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ES 1.0 INTRODUCTION

Chevron Mining Inc. (also referred to as Molycorp[1] in this document) owns and operates a molybdenum mine in Taos County, New Mexico located approximately 3.5 miles east of the village of Questa with an associated tailing facility just west of the village. Chevron Mining Inc. (CMI) has mined molybdenum at the Site for nearly 90 years, with three distinct operational phases: (1) conventional underground mining occurred from about 1919 to 1958, (2) open pit operations were conducted from 1965 to 1981, and (3) the current operation as an underground block cave mine started in 1983. In addition to the mine itself, CMI operates a mill, a tailing pipeline that runs along State Highway 38, and a tailing facility as part of the ongoing operations. These mine site and tailing facility features, as well as all other areas where any hazardous substance, pollutant, or contaminant from mining, milling, and tailings disposal operations has come to be located, comprise the Molycorp Site (hereinafter the "Site" or "Molycorp Site"). These Site features are shown on Figure ES-1.

A Remedial Investigation (RI) was initiated in September 2001 as part of the Remedial Investigation/Feasibility Study (RI/FS) agreed to as part of the Administrative Order on Consent (AOC) with EPA. The objectives of the RI/FS are:

- By conducting a Remedial Investigation, determine the nature and extent of contamination and any threat to the public health, welfare, or the environment caused by the release or threatened release of hazardous substances, pollutants, or contaminants (hereinafter "contaminants") at or from the Site.
- By conducting a Feasibility Study, determine and evaluate alternatives for remedial action to prevent, mitigate, or otherwise respond to or remedy any release or threatened release of contaminants at or from the Site or facility.

The RI/FS process includes three components: the remedial investigation, the risk assessment, and the feasibility study.

This RI report describes the results of the investigation and the nature and extent of contamination at the Site. Data collected during this investigation also are used in the risk assessment and the feasibility study. The risk assessment, which addresses the threat to the public health, welfare, or the environment, is being prepared by EPA. The Feasibility Study will evaluate alternatives for remedial action based on the risk assessment and is in progress.

The sampling and analysis conducted for the RI was performed under EPA oversight in accordance with the Final Molycorp Remedial Investigation/Feasibility Study Work Plan (Work Plan), with modifications approved or prepared by EPA.

The remainder of this Executive Summary provides a summary of the Site investigations at the mine site and tailing facility (Section 2.0) and a summary of the results and conclusions (Section 3.0).

[1] Molycorp, Inc. became Chevron Mining Inc. (CMI) in 2007 through corporate merger.

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ES 2.0 SITE INVESTIGATION

The RI included a comprehensive Site Investigation to: (1) characterize potential contaminant sources for the Molycorp Site (the mine site, tailing facility and pipeline corridor); (2) identify the presence or absence of chemicals of potential concern (COPCs), and if present; (3) describe the nature and extent of COPCs in media. Human health and ecological COPCs were selected and approved by EPA and are summarized on Table ES-2.

All waste rock piles at the mine site, tailing at the tailing facility, and tailing from historic spills along the tailing pipeline were characterized during the RI or as part of previous investigations that were incorporated into the RI, as appropriate, to define potential sources of contamination. The media investigated included air, surface soil (up to 24 inches deep), terrestrial biota (vegetation and animals), groundwater, surface water, sediments, and aquatic biota. In addition to the sampling and analysis of these media, geophysical investigations at the mine site and tailing facility were conducted to characterize subsurface conditions influencing groundwater flow.

All samples collected during the RI were analyzed and validated in accordance with the Quality Assurance Project Plan (QAPP) and validated data were entered into the Molycorp project database. Approximately 7,000 water samples, 1,900 solid samples, and 1,200 biota samples were collected and analyzed during the RI.

Other related studies were conducted either as part of the RI, or as part of other programs at the Site. Two of the investigations were part of the Final RI/FS Work Plan (URS 2007a), the historic tailing spill investigation (URS 2007g) and EPA's focused studies (EPA 2004a). Data collected during the Wildlife Impact Study (URS 2004b) was used to supplement the vegetation characterization data collected as part of the RI (Section 2.5). Private water wells and residential taps were sampled and analyzed by EPA contractors at the request of Questa residents. Other studies conducted during the Molycorp RI that are relevant to the RI include air quality and fuel storage tank investigations and other previous and historical investigations conducted at the Site. Historical investigations were reviewed during the RI to identify existing data to use for characterization of the various Site media. CMI performed a QA/QC review of the existing data presented in these documents and identified usable data to include in the project database. The results of these other studies are incorporated into the RI Report (Sections 3 to 8) by reference, where relevant to the characterization of the media.

ES 2.1 SOURCE CHARACTERIZATION

A conceptual site model identifying potential sources of contamination at the mine site and tailing facility was developed in the RI/FS Work Plan (URS 2007a) and finalized in EPA's risk assessment (CDM 2007a). Each potential source was evaluated in the RI either through collection of data and investigations, or by using data and information presented in previous studies. Table ES-1 presents the potential sources evaluated during the RI for the mine site and tailing facility. The following presents the characterization of sources at the mine site and tailing facility based on previous investigations with a summary of additional data collected during the RI to further evaluate the source and potential for a release from the source.

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ES 2.1.1 Mine Site Source Characterization

Open Pit Soils

The open pit is approximately 3,000 feet in diameter and covers 162 acres. A large natural hydrothermal scar was excavated on the northwest side of the pit that was rich in pyrite. Three geologic units define the pit material, aplite porphyry, black andesite, and mixed volcanics (composed of altered andesite [propyllitic and weathered], rhyolite, and quartz latite volcanics). Field paste pH values range from 6 to 7 for aplite porphyry, near neutral for black andesite, and 3.5 to 5.5 for mixed volcanics. Metals were detected in surface samples. The variability of acid generating characteristics represents the range of lithology. Additional soil samples were collected in the open pit during the RI to further characterize metals and other inorganics in the soil.

Subsidence Area

The existing subsidence area is a topographic depression in the Goathill Gulch drainage. Pyrite occurs in the uppermost zone for the Goathill subsidence. Typical field paste pH values range between 2.5 and 4.5. Metals were detected in surface soil samples. The possibility of the subsidence area as a potential contaminant source was evaluated through the groundwater investigation during the RI. No samples were collected in the subsidence area.

Mill Area/Miscellaneous Independent Sources

The mill area sources include the crushers, mill and concentrator building, grinding, drying, packaging, chemical storage, assay lab, fuel storage, former drum storage, thickeners, warehouse, decline shop, power plant, vehicle maintenance, boneyard, portal, and historic mine site tailing. The majority of the historic mine site tailing have been covered and reclaimed. A small area of tailing material within a road cut remains uncovered.

During operations, physical processing of the mined material occurs in the mill area. This includes crushing, grinding, flotation, drying and packaging of the molybdenite (MoS2).

Chemicals and fuels currently stored in bulk at the mill site are diesel, lube oil, and mill reagents. Historically, older materials stored in bulk included automatic transmission fluid, methanol, and a one-to-one mixture of ethylene glycol and water (automotive antifreeze). Mill reagents (pine oil, diesel, Oreprep F501) are stored in tanks. These products are non-toxic. Diesel fuel and lube oil are used at the power plant. Metals and PCBs were detected in surface soil samples in the mill area. Soil sampling and groundwater monitoring were performed in the mill area during the RI to assess the potential for releases from sources in the mill area.

Administration and Maintenance and Electrical (M&E) Area/Miscellaneous Independent Sources

Potential sources in this area include independent sources such as aboveground tanks, underground storage tanks, and the maintenance and electrical (M&E) area adjacent to the shafts where the dry shop, machine shops, warehouse, maintenance, and engineering buildings and storage yard are located. Fuel and oil are stored along with used oil, used antifreeze, and oily water. Metals were detected in surface soil samples. During the RI, soil and groundwater samples were collected to evaluate the potential for releases in the Administration and M&E area.

Mine Site Miscellaneous Independent Sources

Mine site independent sources are those sources outside the mill and administration and M&E areas. These potential sources include explosives storage areas, historic fueling areas, former truck shop area, transformers and core shack/former carpenter shop. Chemicals associated with independent sources include ammonium nitrate/fuel oil (ANFO) and explosives in the explosives storage areas, PCBs near transformers, fuel, diesel and oil in the fueling areas and solvents/organics in the truck shop and core shack/carpenter shop. There have been no previous documented soil investigations. During the RI, soil and groundwater were investigated to evaluate potential releases from these sources.

Rock Piles

Rock piles at the mine site include Capulin, Goathill North, Goathill South, Sugar Shack West, Sugar Shack South, Middle, Sulphur Gulch South, Spring Gulch and Sulphur Gulch North/Blind Gulch. A number of investigations have been conducted to evaluate geotechnical and geochemical properties of the rock piles. The physical, chemical and geochemical characterization of each rock pile is summarized in Sections 4.2.3, 4.2.4.10 and Tables 4.2-1, 4.2-8 and 4.2-9. Additional characterization of the rock piles was performed as part of the RI to further supplement site specific data for the investigation. Also, surface soil samples were collected to further characterize metals and other inorganics in surficial waste rock material. Groundwater investigations were conducted to evaluate potential releases from these sources.

Historic and Current Spring Gulch Landfills, Former Goathill Landfill and Underground Debris Stockpile

There are four construction and demolition debris landfill areas at the mine site. Historic Spring Gulch was used for construction and demolition debris and office waste. Former Goathill Gulch located south of the subsidence was used for construction debris and underground mine solid debris. The underground debris stockpile was formed as construction material from the underground workings was removed. These three landfills are not currently used. Spring Gulch landfill is the only area being used for construction and demolition debris. The Spring Gulch and Goathill landfills were evaluated as potential sources. During the RI, soil and groundwater were investigated to evaluate potential releases from these sources.

Goathill Gate Gas/Diesel USTs and Other Current Non-Gasoline USTs

Certain underground storage tanks (USTs) and aboveground storage tanks (ASTs) at the Site were evaluated as part of investigations conducted for the Petroleum Storage Tank (PST) Bureau of NMED's Environmental Protection Division and the Groundwater Quality Bureau (GWQB) of NMED's Water and Waste Management Division. Used oil, gasoline, and diesel fuel were contained in these tanks. For the tanks that were removed, excavation was conducted and samples

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were collected in accordance with regulatory standards set by the NMED PST Bureau. Soil and groundwater samples were collected and analyzed for TPH (GRO and DRO), VOCs and PAHs. Constituents were detected in soil but were not detected in groundwater. Sampling of monitoring well MMW-48A is conducted annually for diesel related target chemicals, as part of a Conditional Approval of the Corrective Action Report for a diesel aboveground storage tank located west of the Maintenance and Electric Shop. Other storage tanks received "No Further Action Status" letters from the PST Bureau. Section 2.10.5 provides a summary of the previous investigations and response actions taken.

Naturally Occurring Mine Site Scars

Many of the valleys north and (to a limited extent) south of the Red River, including Goathill Gulch and Sulphur Gulch, contain natural areas of hydrothermally altered, brecciated, and highly erosive rock that are locally referred to as hydrothermal scars. At least 20 scars are present in the area north of the Red River, extending from near the town of Red River through the mine site and west to Capulin Canyon and Questa. Scar areas are typically characterized by yellow-stained, easily eroded materials. Field paste pH values in soil range from less than 2.5 to 3.2. Total metals results for surface samples from scars from previous investigations indicated that most metal concentrations were higher than that found in naturally occurring soils.

Additional characterization of the naturally occurring mine site scars was conducted during the RI to evaluate these features as a potential source of contamination. Also, groundwater investigations were conducted to assess potential releases from these sources.

ES 2.1.2 Tailing Facility Source Characterization

Tailing solids from the tailing impoundments were characterized in previous investigations (Section 5.1.1.3.1). The tailing has a near-neutral pH. Some oxidation of the tailing is taking place, but acid produced is neutralized by carbonate within the tailing. The tailing contains elevated levels of some metals. During the RI, additional characterization of the tailing impoundments was performed. Surface samples of tailing material, water samples, and sediment samples within the ponded area of the impoundment were collected. In addition, a historic tailing spill investigation (Appendix 6.1-3) was conducted to identify where potential spills occurred along the pipe line, the estimated volume of the spill, and chemical analysis of spilled tailing and adjacent soil.

The dry/maintenance area was used for vehicle and equipment maintenance, and various buildings existed in the area over the years. Soil samples were collected to evaluate whether releases of petroleum products or solvents had occurred in the area.

The IX plant was used in the 1980s to treat tailing water prior to permitted discharge. The IX process is an ion exchange technology that uses resins for removal of molybdenum from water. Pope Lake was designed as a holding pond for water treated by the IX plant. Soil samples were collected from these areas to evaluate whether releases of metals or other organics occurred due to spills of chemicals brought on site for treatment, breaks in pipes, etc.

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ES 2.2 SOIL SAMPLING

Surface soil samples were collected at a total of 629 sites from the mine site, the tailing facility, riparian areas along Red River, and the associated reference areas. Soil sampling included waste rock at the mine site, tailing at the tailing facility, and tailing at historic spills along the tailing pipeline. For the purposes of the RI, these samples are referred to as soil samples. Most of the soil sampling occurred from October 2002 to December 2003. Generally, two separate soil samples were collected at each location: 0 to 6 inch deep sample to evaluate risk to humans via incidental ingestion, dermal contact, or inhalation; and 0 to 24 inch deep samples to evaluate risk to ecological receptors.

Sample locations were selected in two ways, using random and focused sampling approaches. Systematic random sampling was used in areas with non-point sources to obtain the necessary sample population from each soil investigation area. Focused soil samples were collected to characterize a source-specific potential release of a constituent. Focused sample locations were selected based on visual evidence of staining, likely routes of contaminant migration, pathways of surface water runoff, and the nature of a potential source in an area. In order to address potential off site, windblown effects at the tailing facility, soil samples were collected along wind-direction transects. For this evaluation, two samples were collected at each transect sampling location: one from 0 to 2 inches (to evaluate the potential effect of windblown tailing), and one from 2 to 6 inches (the reference sample).

The majority of the soil samples were analyzed for metals and other inorganics. Other analyses were performed on select samples as follows:

- Volatile organic compounds (VOCs) and semivolatile organic compounds (SVOCs) were analyzed to evaluate the potential presence of fuels and solvents in samples collected near fuel storage tanks, former or current drum storage areas, former and current landfills, the maintenance shop, the electrical shop, the power plant, the laboratory, the dry/maintenance area, and from areas of stained soil.
- Polychlorinated biphenyls (PCBs) in soil samples collected near transformers or historic transformer locations.
- SVOCs (from fuel oil associated with the ammonium nitrate/fuel oil) and explosives in soil samples collected from the former and current explosives storage areas.
- Polychlorinated dibenzo-p-dioxins (PCDDs), polychlorinated dibenzofurans (PCDFs), and pesticides in selected soil samples to determine if these compounds are present at the Molycorp Site.
- The Synthetic Precipitation Leaching Procedure (SPLP) was used to evaluate potential leaching of metals to groundwater on selected samples of mine site soil, rock pile soil, tailing, windblown particulate deposition soil, riparian soil, and reference soil.

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ES 2.3 TERRESTRIAL BIOTA SAMPLING

Terrestrial biota samples (vegetation and animals) were collected from September 2002 through August 2003 at the mine site, the tailing facility, riparian areas along Red River, and associated reference areas. Also, garden produce samples were collected from areas in and around the village of Questa. Vegetation studies were conducted to evaluate the potential effects of the soils on plants and vegetation communities, and the potential effects of the vegetation on humans or animals that may consume the vegetation. One or more of these evaluations occurred at 122 sites. Small mammals and terrestrial invertebrates were sampled to evaluate the potential effects to higher trophic level species. Vegetation and animal tissue samples were collected for metals analyses from areas co-located with soil samples. Small mammals and/or terrestrial invertebrates were collected at 108 sites.

The RI efforts to characterize the terrestrial biota were focused on areas of the Site that were likely to have complete exposure pathways for populations of terrestrial receptors. The areas sampled were considered likely to be terrestrial habitat. For example, no soil samples were collected for the earthworm and rye grass bioassays for Soil Areas 1 (mill), 2 (administration), 4 (waste rock piles), 6 (open pit), and 8 (other mine site independent source areas) because EPA agreed that these areas were affected by mining-related activities, had little to no flora populations and therefore, could not support terrestrial habitat. Additionally, no tissue samples from plants or trees were collected in those areas to assess metals uptake due to a lack of vegetation. The nature and extent of contamination of the primary source media was characterized in these areas. Sampling of Soil Area 8a (explosives storage areas) 8b (historical fueling area), 8c (landfills), 8d (former truck shop area), 8e (transformers) and 8f (core shack and former carpenter shop) was designed to be used 1) to evaluate potential releases of a specific chemical from point source Soil Area 8 locations and 2) to evaluate risk in whichever larger area they fell. For example, Soil Area 8e sampling was targeted at PCBs in transformer locations, with sample MSS8-TF5 collected at a transformer location in Slick Line Gulch in EA-3 and the rest collected in and near the truck shop area. The analytical data for Aroclors were nondetectable in all of these samples indicating there had not been detectable releases of PCBs in Soil Area 8e. Risk associated with chemicals other than PCBs was evaluated through the sampling of the soil area within which the Soil Area 8e samples happened to fall. PCBs were not found to pose a risk at Soil Area 8e sample locations. PCBs were also evaluated at the Mill (Soil Area 1). CMI therefore concluded that Soil Area 8e was not affected by Aroclor releases from transformers but that Soil Area 1 was affected by mining-related activity. The RI/FS sampling approach assumed that standard risk assessment fate and transport and exposure modeling would be performed by EPA in their risk assessment and is appropriate for this purpose.

Large grain size and lack of organic matter in rock pile materials are physical conditions that eliminate or reduce plant and invertebrate communities necessary as prey or forage for higher trophic-level animals. Therefore, the RI effort did not include terrestrial biological sampling at the rock piles, assuming that any potential for risk could be predicted by EPA in their ecological risk assessment from extrapolation from data collected from other areas of the Site, which represent a wide range of conditions.

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ES 2.4 GROUNDWATER INVESTIGATIONS

Extensive groundwater data were collected during the RI in the area of the mine site, the tailing facility, and associated reference areas. Data collection included the installation of new wells and piezometers; sampling of new and existing wells, seeps, and springs; aquifer testing (slug and pumping tests); and a colloidal borescope investigation.

Quarterly sampling of all groundwater sampling locations was performed, which typically totaled 150 wells and springs at the mine site and tailing facility and reference areas. Quarterly sampling occurred in October/November 2002; January, April, and October 2003; and January and April 2004. In addition, about 50 wells at the mine site and tailing facility were sampled monthly. Initial RI groundwater sampling included limited additional sampling through June 2006. Additional sampling subsequent to this date, up through mid-2008, occurred and is included in Appendices 1.0-1 and 1.0-2.

Groundwater samples collected during the RI were analyzed for total and dissolved metals and other inorganics and field parameters (dissolved oxygen, reduction-oxidation potential [Eh], pH, and specific conductance). Additional or special analyses were performed at select samples as follows:

- Chromium (VI) on samples from select wells and springs site wide.
- VOCs and SVOCs on selected wells and seeps site wide.
- Explosives in selected wells at the mine site.
- Lead and sulfur isotopes and lanthanides at selected mine site wells to assist in evaluating potential source areas.
- Stable isotopes of oxygen and hydrogen (^{18}O and ^{2}H) at select wells, seeps, and underground locations to evaluate the similarities or dissimilarities in physical processes of water recharging these locations.
- Tritium and helium at several wells and springs to estimate the age of the water.

Historical groundwater monitoring data were reviewed, added to the project database, and used in evaluations. In addition to monitoring, hydraulic testing and a colloidal borescope study were conducted. Hydraulic testing, including slug tests and a pumping test, occurred at selected wells at the mine site in March 2004 to estimate the hydraulic properties of the colluvium/debris flow.

ES 2.5 SURFACE WATER AND SEDIMENT SAMPLING

Surface water and co-located sediment samples were collected from streams, lakes, ponds, unique habitats (i.e., beaver ponds), storm water catchments (surface water only), drainages upstream of the mine, irrigation ditches, irrigation return flow ditches, and tailing impoundments. During the RI, surface water samples were collected from a total of 97 sites and sediment samples were collected from 81 sites.

Sampling sites along the Red River were selected to provide up- and downstream bracketing of defined sources within the mine area, such as springs and tributaries. Sites on Red River

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upstream of the mine and on Cabresto Creek were sampled as a reference for Red River along the mine site and tailing facility. Surface water and sediment were sampled at most of the Red River and Cabresto Creek sites during the four seasonal RI events in September/October 2002, March 2003, July 2003, and September 2003. Additional surface water samples were collected as follows:

- Samples at select Red River sites were collected during snowmelt in April 2003.
- Samples at select Red River sites were collected during four storm events in summer 2003 (in July, August, and during two events in September), and during one post-storm event in September 2003.
- Samples at select Red River sites were analyzed for stable isotopes (^{18}O and ^{2}H) to collect potential data related to the origin of the water.
- Samples at select Red River sites were collected during the Groundwater/Surface Water Interaction studies (October 2003, April 2004, and September 2004).

The surface water and sediment samples were analyzed for metals and other inorganics, with a subset of samples analyzed for VOCs, SVOCs, and explosives. A subset of surface water samples were analyzed for chromium (VI). A subset of sediment samples were analyzed for PCBs, pesticides, PCDDs, and PCDFs. Sediments from lakes also were analyzed for acid volatile sulfides/simultaneously extracted metals (AVS/SEM).

ES 2.6 AQUATIC BIOTA SAMPLING

Sampling of components of the various aquatic biota was conducted at 20 sites co-located with surface water and sediment sampling sites to evaluate potential impacts to aquatic life in Red River, lakes, and ponds near the mine site and the tailing facility. The RI sample collection occurred during select quarterly sampling events from September 2002 through September 2003. Components of the aquatic ecosystem sampling included the following:

- Fish population
- Metal analysis of fish tissues
- Benthic macroinvertebrate (including aquatic insects) population
- Metal analysis of the macroinvertebrate tissue
- Aquatic habitat evaluation
- Attached algal population
- Metal analysis of aquatic plants tissue
- Surface water and sediment bioassays

In addition to data collected specifically for the RI, data on fish populations, macroinvertebrate populations, and habitat were collected prior to and after the RI field sampling period as part of routine biological monitoring that Molycorp has performed since 1997. Additional data also

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were available from surface water and sediment toxicity tests prior to the RI field sampling period as part of a total maximum daily load (TMDL) study conducted in 1999. These non-RI data were used to supplement the RI data in the evaluation of potential impacts to aquatic life.

ES 2.7 WASTE ROCK PILE CHARACTERIZATION

The waste rock piles at the mine site are all considered to be sources or potential sources. This is derived from various sources of information including the soil sampling data from the RI, the available historic data from the waste rock piles, and the Roadside Rock Pile Characterization Study (Sections 2.8 and 4.2). This information was used in conjunction with the historic data to effectively evaluate sources and potential sources from the rock piles.

A focused rock pile investigation was conducted in June and July 2005 to address additional data needs for assessing the nature and extent of elevated constituents in colluvial water under the roadside rock piles at the mine. The scope of this work was to (1) geochemically and mineralogically characterize the roadside rock piles and the surrounding lithologies (waste rock, colluvium, debris flow, bedrock, and scar), (2) determine the static acid generating potential of these materials, and (3) evaluate whether these materials were sources that could impact groundwater and surface water at the mine site. Samples used for this characterization included subsurface samples collected from boreholes drilled in previous investigations and surficial samples collected from scar and debris fan material during the RI. The analyses performed on the samples include the following:

- Particle size analysis
- Analysis of metals, other inorganics, paste pH, and paste specific conductance
- Acid base accounting
- Leach tests
- Mineralogy/petrography

ES 2.8 GEOPHYSICAL INVESTIGATIONS

Non-intrusive geophysical methods were used for subsurface characterization. Generally, the geophysical investigation produced data to characterize the bedrock, thickness of overburden or overlying lithologic units, location of fault or significant fracture zones, and other preferred pathways for groundwater flow (e.g., paleochannels). Because of these varied characterization needs, several geophysical methods were used including magnetics, seismic reflection, seismic refraction, and downhole methods.

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ES 3.0 RESULTS AND CONCLUSIONS

ES 3.1 MINE SITE

The results and conclusions for the mine site terrestrial media (soils, vegetation, animals), groundwater, and aquatic media (surface water, sediment, and aquatic biota) are presented in the following sections.

ES 3.1.1 Terrestrial Media

Terrestrial media were evaluated in five soil exposure areas identified by EPA. Additional terrestrial areas or media evaluated included campground soils, edible riparian vegetation, and mine site catchment water. This evaluation focused on whether there are measured differences in the chemistry and/or biology that may be related to mining between each of these exposure areas and reference areas. Lines of evidence discussed below include exceedance of human health and ecological screening level criteria (SLC) for organic COPCs in soils (if analyzed); statistically significant differences from reference for metal COPCs in soils, vegetation, small mammals, and earthworms; differences in soil fauna and plant community composition; and statistically significant differences from reference in bioassay results for ryegrass and earthworms.

It is noted that, although during the RI/FS scoping EPA directed Molycorp to include sampling of vegetation at locations on waste rock piles for analysis of metals uptake and assessment of potential risk to terrestrial receptors, such sampling was dropped from the RI when a Molycorp reconnaissance team reported inadequate vegetative growth on the rock piles for conducting the analyses. In addition, small mammals were only collected along the edge of one rock pile due to a lack of habitat. However, it is noted that sampling of vegetation and small mammals on rock piles was dropped from the study with the concurrence of the EPA and as a result of the joint Molycorp and EPA reconnaissance visit prior to finalizing the Field Sampling Plan (URS 2007c). The Field Sampling Plan (URS 2007c) approved by EPA did not include sampling of vegetation or small mammals at the rock piles.

The sampling program documented in the Field Sampling Plan (URS 2007c) approved by EPA was extensive. The effort included chemical analysis of all abiotic media (i.e., soil, surface water, scar, waste rock, tailing). In addition, biological data were collected, including tissue chemistry, community structure, and toxicity testing. Areas that were not identified in the Field Sampling Plan (URS 2007c) as important ecological habitat lacked the more intensive biological data. Instead, the other lines of evidence collected as part of the RI were considered sufficient to characterize the nature and extent of contamination in order to evaluate the potential for ecological risk. Abiotic media chemistry data, collected at all locations, are the basis of the exposure point concentrations used to make quantitative estimates of ecological risk known as hazard quotients. The extensive data for the Site were used by EPA to develop estimates of risk.

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Human Health – Mine Site and Mine Site Riparian Areas

Mine site areas evaluated for human health COPCs had few organic COPCs that exceeded the human health SLC or metals that were greater than reference (Table ES-1). The most significant finding was the presence of the organic COPC PCBs and the inorganic COPC molybdenum in the mill area that exceeded human health SLC.

For campgrounds in the mine site riparian area, no metal COPCs concentrations were significantly greater than the reference area.

Ecological Evaluation – Mine Site and Mine Site Riparian Areas

Plant and earthworm bioassays were not performed on samples from the rock piles because large grain size and lack of organic matter in rock pile materials are physical conditions that fall outside of the scope of standard bioassay methodology. The decision to exclude the rock pile material in the bioassay toxicity testing was based on the recognition that the rock pile material lacked standard soil properties conducive to survival of test organisms, and in addition was fairly acidic. Therefore, it was assumed that ryegrass and earthworms would not survive the bioassay tests regardless of chemical characteristics. Instead, other lines of evidence were used to characterize the nature and extent of contamination in order to evaluate the potential for ecological risk at the waste rock piles; the rock piles were evaluated for risk to ecological receptors based on measured soil chemistry, including pH.

The standard operating procedures for the earthworm and ryegrass bioassay tests that were conducted at other locations included a pH adjustment to buffer out acidity. It is recognized that pH could play a significant role in the toxicity of the rock soil at the mine site because pH affects the solubility and mobility of metals. Note that pH confounds metal toxicity; if pH is too high or too low, pH itself would be toxic to soil flora and fauna and pH toxicity could not be separated from that of metal toxicity in the absence of a research-level effort. It is further noted that plant and earthworm bioassays on rock piles were dropped from the study with the concurrence of the EPA and as a result of the joint Molycorp and EPA reconnaissance visit prior to finalizing the Field Sampling Plan (URS 2007c). The Field Sampling Plan approved by EPA did not include bioassays at the rock piles.

Small mammals collected at the mine site rock piles did not appear to have a higher body burden of COPCs compared to reference area small mammals. In addition, little evidence of potential adverse effects was seen from mine-related contamination for samples collected at areas of the mine site, which for the most part, excluded waste rock pile areas.

Many of the COPCs exceeded the ecological SLC in one or more samples at the mine site. Seventeen COPCs exceeded the soil SLCs in the mine site soils (EA-4) including aluminum toxicity (soil pH <5.5), antimony, barium, boron, cadmium, chromium, copper, iron toxicity (soil pH <5 and >8), lead, manganese, molybdenum, nickel, selenium, silver, thallium, vanadium and zinc. All of these, plus arsenic, cobalt and mercury, exceeded the soil SLC in at least one sample in the rock piles (EA-3). However, only a few COPCs had concentrations significantly greater in EA-4 than the reference area, including copper and thallium in EA-4 soils and selenium and thallium in vegetation. There were no COPCs in EA- 4 scars, earthworms or small mammals in

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elevated concentrations. At the rock piles (EA-3), six COPCs had exposure area concentrations higher than reference, including chromium, copper, manganese, molybdenum, nickel, and thallium.

Mine site riparian results indicate significantly elevated concentrations for 15 COPCs in one or more terrestrial media (e.g., soil, vegetation, or animals) compared to the reference area. They include arsenic, barium, boron, cadmium, chromium, copper, iron, lead, manganese, molybdenum, nickel, selenium, silver, thallium and zinc. All of these COPCs except nickel also exceeded the ecological SLC at one or more sample sites. Aluminum toxicity (soil pH <5.5) and vanadium concentrations exceeded the soil SLC but were not statistically different from reference.

Vegetation and soil fauna community data did not exhibit significant differences nor did plant and earthworm bioassays, suggesting that the measured differences in the chemical environment may have little effect on the biological environment in areas of the mine site excluding the waste rock piles. Risk to terrestrial receptors, including plants, from potential exposure to waste rock is assessed as part of the Ecological Risk Assessment (CDM 2007c) conducted by EPA.

Bioaccumulation

Several COPCs had bioaccumulation factors above 1.0 at the mine site and/or mine riparian area, but the results were generally similar to the reference areas. With the exception of the below ground vegetation at the mine site, the graphed results showed the limited number of significant correlations between COPC concentrations in vegetation and soils. The larger number of correlations for below ground vegetation is likely due to soil adhering to the plant making it appear as if the unwashed plants were correlating with the soils.

Edible Riparian Vegetation

Two species of edible riparian plants were sampled in the mine and reference riparian areas. COPC concentrations were generally similar in riparian and reference riparian areas.

ES 3.1.2 Groundwater

In the vicinity of the mine site, groundwater occurs in three primary units: Red River alluvium, colluvium, and bedrock. In general, groundwater in the mine area, except for what is captured by the open pit and underground workings, flows from the mountain ridges into the colluvium in the major side drainages and flows in a generally southern direction until entering the Red River alluvial aquifer at the mouths of the drainages. After entering the alluvial aquifer, the groundwater migrates along the north side of the alluvial aquifer and eventually disperses, mixing with the less impacted groundwater of the Red River alluvial aquifer, while continuing to flow downgradient in a westerly direction parallel to the Red River. However, the flow regime in the colluvium and shallow bedrock within some side drainages may have been modified by the presence of the open pit and by the pumping of water from the underground mine workings and may not follow the general flowpath described above.

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ES 3.1.2.1 Red River Alluvial Groundwater

The alluvial aquifer is highly transmissive and occurs within sediments along the Red River floodplain. The alluvial aquifer receives water from upstream of the mine site, and from north and south watersheds along the mine site.

Alluvial groundwater is affected in part from mine-related activities (Table ES-1). All of the waste rock piles are sources or potential sources of contamination to the Red River alluvial aquifer, either historically, currently, or in the future. Along the mine site, sources of metals and acidity include leaching of the roadside rock piles (Sulphur Gulch, Middle, and Sugar Shack South), and leaching of naturally occurring hydrothermal scars and debris fans. Sugar Shack West, Sulphur Gulch North, Blind Gulch, and Spring Gulch rock piles are possible sources as well. Capulin and Goathill North and South waste rock piles are not likely current sources to the alluvial aquifer because the leachate is collected and diverted to the subsidence zone where it enters the underground mine. However, they are historic sources to alluvial aquifer contamination, as seen in groundwater chemistry from wells at the mouths of those drainages in the early 1990s[2]. In addition, the chemical nature of alluvial groundwater is affected by sources upstream of the mine that produce acidity and metals that mix with alluvial groundwater near the mouth of the drainages (e.g., Hottentot, Straight, and Hansen creeks).

Concentrations increase from upstream to downstream, along the roadside rock piles due to leaching of waste rock, natural scar material, and debris fan sediments. The north side of the alluvial aquifer (where the mine site is located) has higher concentrations than the south side as the constituent plume hugs the north side of the alluvial valley.

From Columbine Creek to Goathill Gulch, concentrations progressively decrease due to dilution from an influx of groundwater from Columbine Creek watershed that also adds alkalinity and dilutes the alluvial aquifer. Pumping of the withdrawal well system along the base of the roadside rock piles and Columbine wells No. 1 and No. 2 also contributes to the decrease in concentrations in Columbine Park.

Concentrations increase near Goathill Gulch as colluvial water from Slick Line Gulch and the Goathill debris fan mixes with the alluvial groundwater. Concentrations decrease downstream of the Goathill Gulch debris fan until reaching the Spring 13 area where concentrations typically double. This is followed by a decrease in concentrations downstream of Capulin Canyon.

ES 3.1.2.2 Colluvial Groundwater

Colluvium occurs within the mine site side drainages. Colluvium hydraulic conductivities are typically two to three orders of magnitude less than values for the alluvial aquifer.

Colluvial groundwater is affected in part from mine-related activities (Table ES-1). All of the waste rock piles are sources or potential sources of contamination to colluvial water either historically, currently, or in the future. Sources of inorganics and acidity to the colluvial water-bearing unit are leaching of the rock piles and natural scar material underlying some rock piles.

[2] The groundwater chemistry near the mouths of these drainages has historically and is currently affected by scar material.

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Erosion of the scars prior to mining resulted in debris fans near the mouth of some drainages. Thus, the debris fan material is also a source in those drainages. It is noted that for some drainages, the scar is not present beneath the waste rock pile, which is typically at the upper end of the drainage, but is located further down the drainage, as well as the debris fan, which settled at the mouth of the drainage (e.g., Capulin, Slick Line drainages). Therefore, for those drainages, the scars and debris fans are not sources of contamination to the colluvial groundwater in upper reaches of those drainages.

Colluvial water generally contains elevated constituents in each of the side drainages that border the river. Concentrations decrease as the water mixes with Red River alluvial groundwater near the mouths of drainages. It is noted that the highest concentrations of metals in colluvial groundwater at the mine site are beneath the Middle Rock Pile in a side drainage that does not contain a natural scar.

ES 3.1.2.3 Bedrock Groundwater

Tertiary volcanic rocks form the primary bedrock water-bearing unit in the mine area. Water within the bedrock occurs within secondary porosity features such as faults, fractures, joints, and joint sets. Water is also present in large void spaces associated with underground mining such as workings, tunnels, shafts, rises, and winzes. These types of mine-related openings typically function as drains that collect water.

The bedrock gradient is relatively steep beneath the roadside rock piles and toward the river. A flattening of the gradient is apparent along Slick Line Gulch and lower Goathill Gulch, which is due to dewatering of the underground mine. The flow direction in Capulin Canyon is generally toward the river at lower elevations that border the river. Bedrock water within the interior of the mine site is directed toward the dewatered underground workings.

The bedrock hydraulic conductivity is typically one order of magnitude less than the colluvium and three to four orders of magnitude less than the Red River alluvium.

Bedrock groundwater is affected in part from mine-related activities (Table ES-1). Sources of constituents in bedrock water include leaching from waste rock, natural scars, and debris fans near the mouths of drainages. The bedrock itself is mineralized in areas of the mine and dissolution of metals is a contributing source to bedrock water.

Bedrock water is typically neutral with elevated concentrations of a few constituents; typically fluoride, manganese, and sulfate. Areas where bedrock water has low constituent concentrations include Capulin Canyon, along the base of the roadside rock piles, and in lower Goathill Gulch.

ES 3.1.2.4 Pre-Mining Groundwater Concentrations

In April 2001, USGS began an integrated study to estimate pre-mining (natural background) groundwater quality at the CMI mine site. The pre-mining groundwater quality study was also intended to provide scientific justification for possible site-specific regulatory standards for groundwater. The study examined the geologic, hydrologic, and geochemical controls on groundwater quality in a proximal analog site in the Straight Creek drainage basin. The mineralogy, elevation, and hydrology of the Straight Creek watershed were found to be similar to

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those at the mine site except for the Sulphur Gulch drainage. Pre-mining concentrations were inferred for water in the colluvium and bedrock within the primary mine site drainages and additionally inferred for the drainages beneath the roadside rock piles. Colluvium and bedrock concentrations were inferred for 15 constituents considered to be COPCs for the purposes of characterizing pre-mining conditions. A summary of the investigations and estimates of pre-mining concentrations is contained in Nordstrom (2008). A reprint of the pre-mining concentration section of that report is contained in Appendix 4.4-5.

Concentrations from the beginning of the RI (fall 2002) through second quarter 2006 were compared to the pre-mining concentrations from the USGS Background Study. Comparisons were made for each colluvial and bedrock well at the mine site for each of the 15 constituents.

Based on previous studies conducted by CMI, this Remedial Investigation and the U.S. Geological Survey's Questa Baseline and Pre-Mining Ground-Water Quality Investigation, No. 25, it has been determined that mining-related activities adversely impacted ground water beneath the Questa mine in all hydrological sub-drainages at concentrations above natural background levels associated with hydrothermal scar and highly-mineralized zones. Also, the impacted ground waters within the sub-drainages have in the past flowed, and presently flow, at least in part, into the Red River alluvial aquifer.

The RI and Background Study also found that the groundwater quality at the mine site has been severely impacted by natural mineralization and hydrothermal scars. The Background Study found that pre-mining groundwater concentrations can exceed numeric groundwater criteria in the New Mexico groundwater standards by as much as 250 times. These natural water-quality impacts pre-date mining activities and continue today.

ES 3.1.3 Aquatic Media

The aquatic media evaluated at the mine site during the RI includes surface water, sediment, and aquatic biota. Sources or potential sources of contaminants to Red River include waste rock within all mine site drainages that contribute groundwater to the Red River alluvial aquifer, natural scars that underlie some of the waste rock piles, and debris fan sediment (containing scar material) at the mouths of some drainages (Table ES-1). The contaminated groundwater within the alluvial aquifer flows into the Red River at zones of groundwater upwelling, including Springs 13 and 39. Natural scars in drainages upstream of the mine are also sources of contaminants to the Red River.

Red River water quality and physical habitat conditions deteriorate during storm events, due to runoff containing scar material from drainages upstream of the mine (Hottentot, Straight, and Hansen creeks). Storm water runoff from these drainages is very acidic and contains metals that discharge to Red River resulting in a visible plume of discolored water as well as periodic mass wasting of sediment into the river. During normal to low-flow conditions, the pH of Red River water is neutral to alkaline (from 6.5 to 8.5). During large storm events acidic runoff from the upstream drainages can reduce the river pH to the mid 3's for at least two hours and the low pH continues along the mine site during large storms. These pulses of acidic conditions in the river may occur due to changes in rainfall intensity and runoff from the upstream drainages and can

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result in acutely toxic conditions to aquatic biota. Storm water runoff from the mine is contained in catchments and does not enter the river. Water in the river is affected in part from mine-related activities where groundwater upwelling occurs. Some storm water infiltrates the waste rock piles, enters groundwater, and can ultimately enter the Red River through areas of groundwater upwelling.

For all surface water COPCs that exceed New Mexico water quality criteria in Red River along the mine site, the criteria also are exceeded in a reference reach upstream of the mine. Aluminum (total) is the only ecological COPC that exceeds the state acute ecological criteria. Aluminum (total), barium (dissolved), boron (dissolved), cadmium (dissolved), and iron (total) exceeded state chronic criteria.

Populations of aquatic macroinvertebrates and fish decline significantly immediately downstream of the town of Red River and upstream of the mine (reference reach EEA-2, located directly upstream of the mine). This is likely the result of high sediment and contaminated groundwater inputs in this reach from the hydrothermal scarring in drainages upstream of the mine.

Aquatic biota sampling adjacent to the mine just downstream of Goathill Gulch (site RR-12), generally showed the highest invertebrate and aquatic plant tissue metal concentrations; however, macroinvertebrate tissue concentrations were not significantly different than the reference area. This is also the only location where aquatic plant tissue concentrations were higher than the mine reference reach. Site RR-12 also showed higher concentrations of mercury in fish tissue in brown trout less than 8 inches compared to the reference area; however, site RR-12 generally had the highest resident trout density of all mine exposure sites.

Aquatic biota samples collected just downstream of the mine site consistently had the poorest aquatic communities, with generally the lowest macroinvertebrate parameters, resident trout density, and resident trout biomass. This sampling location, site RR-15, seems to assimilate the adverse aspects of the watershed, rather than having a single limiting factor. Reach EEA-6 had the most surface water COPCs that were greater than reference (10), the highest number of sediment COPCs that were greater than reference (8), and continuing high sedimentation in the streambed. Reach EEA-6 extends from just upstream of Capulin Canyon to Cabresto Creek.

ES 3.2 TAILING FACILITY

The results and conclusions for the tailing facility are presented for the terrestrial media (soils, vegetation, and animals), groundwater, and aquatic media (surface water, sediment, and aquatic biota) in the following sections.

ES 3.2.1 Terrestrial Media

Like the mine site, this evaluation focused on whether there are measurable differences in the chemical and biological environment between the exposure and reference areas that may be related to mining. Terrestrial media were evaluated in four soil exposure areas identified by EPA. Other terrestrial areas or media evaluated include garden vegetables, the tailing impoundments, and irrigation ditches.

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Human Health Results

At the tailing facility only one organic COPC, benzo(a)pyrene, for soil exceeded human health SLC. South of the tailing facility, iron and molybdenum in soil were significantly greater than the reference area concentrations.

Ecological Results

For the tailing facility, concentrations of 10 COPCs were significantly elevated in one or more media compared to the reference area. As expected, molybdenum was substantially higher relative to the reference area. However, the tailing facility vegetation and soil fauna community data did not show adverse effects, but were more biologically diverse than at the reference area. The small mammal community was also more diverse at the tailing facility than at the reference area. Plant bioassays for the two areas showed no significant differences, whereas the earthworm bioassay for the tailing facility exhibited a significant reduction in earthworm reproduction. These results suggest that while the measured differences in the chemical environment may have the potential to cause some limited adverse effects on the biological environment, other factors such as land management may have a greater beneficial effect.

For the tailing riparian area, concentrations of 10 COPCs were significantly elevated compared to the reference concentrations in one or more sample media. There were no significant differences in concentrations of COPCs in small mammals. The soil fauna biometrics and earthworm bioassays did not exhibit any significant differences, but the tailing riparian area ryegrass bioassay had significantly reduced total biomass relative to the reference area. Vegetation community data did not exhibit any differences that are likely to be due to differences in the chemical environment. As only one line of evidence exhibited a potentially adverse effect, these results suggest that the measured differences in the chemical environment may have little effect on the biological environment.

South of the tailing facility, concentrations of 10 COPCs were significantly higher compared to the soil reference concentrations. This exposure area had reduced cover compared to the reference, but the difference was caused by the nature of the plant community that dominated the areas—agricultural meadows compared to riparian forests in the reference area. Therefore, it seems unlikely that measured differences in the chemical environment are affecting the biological environment.

Bioaccumulation

Several COPCs had bioaccumulation factors above 1.0 in vegetation at the tailing facility and/or tailing riparian area, but the results were generally similar to the reference areas. The molybdenum BAF of 2 to 4 in forbs at the tailing facility may have been influenced by use of alfalfa as a sample species; grasses and shrubs were not elevated. The graphing results show a limited number of significant correlations between COPC concentrations in vegetation and soils for the RI data. The results from the WIS at the tailing facility found more significant correlations for the six COPC's that were analyzed in detail, possibly because of differences in methods used to collect soil samples.

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Garden Vegetables

COPC concentrations in vegetables were generally similar among the different gardens and reference gardens. Median concentrations of molybdenum were higher in garden beans than in other vegetables or reference garden beans. COPC concentrations in both garden and reference garden vegetables were generally very low compared to concentrations in wild plants at the tailing facility and reference.

Tailing Impoundments

The general water quality within the impoundments reflects the chemical nature of the tailing and process water from milling operations. Lime is added in the milling process and the resulting neutralization is evident as the water is neutral to slightly alkaline. Concentrations of sulfate, total dissolved solids, manganese, molybdenum, and fluoride are elevated.

Irrigation Ditches

The quality of water in irrigation ditches is similar to the source water (i.e., Red River and Cabresto Creek).

ES 3.2.2 Groundwater

Groundwater occurs in piedmont alluvial sediments beneath the tailing facility and to the east, and within volcanic flows of the Guadalupe Mountains and Servietta flood basalts west of the tailing facility. Groundwater local to the tailing facility occurs in three primary units: upper alluvial aquifer, basal alluvial aquifer, and basal bedrock (volcanic) aquifer. Available chemical data indicate that tailing seepage from the impoundments is hydrologically connected to the underlying upper alluvial and basal volcanic aquifers.

Upper Alluvial Aquifer

The upper alluvial aquifer is a mixture of recent alluvial sediments. The sediments range from coarse-grained sand and gravel to silts and clays. The upper alluvial aquifer pinches out to the west under the western impoundment.

The water table generally follows the topography of the alluvial pediment. The groundwater flow direction is toward the south-southwest. Discharge of tailing water has created an area of higher than normal water table that covers much of the two tailing impoundments. Although the water table in the impoundments has increased, the flow direction continues toward the south-southwest in line with the pre-existing arroyo orientation. Pumping of extraction wells in the seepage interceptor system located in the arroyo south of Dam No. 1 further induces a south-southwest component of groundwater flow downgradient of Dam No. 1. At the east flank of Dam No. 4, an eastward component of groundwater flow exists, likely caused by mounding groundwater levels beneath the impoundment and an induced hydraulic gradient by the seepage interceptor system on the east side of the impoundment.

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Tailing seepage from the eastern and western impoundments is a source of metal and other inorganic constituents to the upper alluvial aquifer. Tailing-impacted groundwater is characterized as neutral water with elevated concentrations of molybdenum, sulfate, manganese, and fluoride (to a lesser extent).

COPCs that are frequently greater than reference include molybdenum and manganese. Total iron, lead, and arsenic are greater than reference in limited areas. Although concentrations of these metals are below reporting limits or detected at low concentrations in tailing seepage, the tailing impoundments are the most likely source of impacts to groundwater downgradient of the facility. The elevated total levels may also be related to natural concentrations of suspended particles in groundwater that were not removed during well development. The naturally occurring concentrations of these metals in reference soil for the riparian area south of the tailing facility is 2.2 to 5.3 mg/kg arsenic; 10,600 to 21,500 mg/kg iron; and 11.5 to 29.9 mg/kg lead (see Appendix 6.1-3). Groundwater near the base of Dam No. 1 has the largest number of COPCs that exceeded reference levels.

Basal Alluvial Aquifer

The basal alluvial aquifer underlies the upper alluvial aquifer and generally begins at depths of around 150 feet. Sediments in the basal alluvial aquifer and its extent are similar to the upper alluvial aquifer.

The basal alluvial aquifer generally follows the alluvial pediment topography like the water table in the upper alluvial aquifer. The flow direction is generally toward the south and southwest.

Tailing seepage from the eastern and western impoundments is a minimal source, if at all, of metal and inorganic constituents to the basal alluvial aquifer. Clay layers and beds in the upper alluvial aquifer minimize downward flow of tailing seepage into the basal alluvial aquifer.

The only groundwater COPC in the basal alluvial aquifer that is statistically greater than reference is molybdenum. However, the molybdenum concentration is near the reference value. Arsenic exceeds reference in one well; however, arsenic in the deep alluvial aquifer is probably not related to operations at the tailing facility. No COPCs along the eastern portion of the tailing facility are greater than reference.

Basal Bedrock Aquifer

Volcanic flows from the Guadalupe Mountains west of the tailing facility make up the basal bedrock aquifer. Groundwater in the basal bedrock aquifer is encountered at depths between 200 and 415 feet at the tailing facility. Groundwater occurs at greater depths beneath the Guadalupe Mountains and ranges from 500 to 900 feet.

The basal bedrock aquifer is not impacted by tailing seepage with the exception of the area south of the Dam No. 4 impoundment and an isolated area south of Dam No. 1 near Red River (location of former well TPZ-5B, based on two sampling events in 2003). At both locations molybdenum concentrations have been detected above the preliminary remediation goal (PRG) of 0.05 mg/L, but below the numeric criteria of 1 mg/L in the NM groundwater standards. Increasing trends in molybdenum concentrations are observed in wells downgradient of the Dam

Executive Summary

No. 4 impoundment, based on historical data through second quarter 2008. Sulfate concentrations have also increased in these well, but concentrations are well below the numeric criteria of 600 mg/L in the NM groundwater standards for sulfate. Increases in molybdenum and sulfate concentrations have also been observed at springs near the river south of Dam No. 4. Increases in concentrations in the bedrock aquifer downgradient of Dam No. 4 are believed to be related to an increase in process water and tailing delivery to the tailing facility. Possible explanations for the elevated molybdenum at former well TPZ-5B are: (1) cross-contamination during the construction of TPZ-5B, (2) residual of past groundwater conditions prior to the operation of the seepage interceptor system below Dam No. 1, and (3) bedrock anisotropy may be responsible for a pathway from the impoundments to TPZ-5B that bypasses other bedrock wells upgradient of TPZ-5B.

COPCs in the basal bedrock aquifer that are significantly greater than reference include molybdenum and to a lesser degree, manganese. Exceedance of reference molybdenum and manganese concentrations in the basal bedrock aquifer only occurs near Dam No. 4.

Water Balance

Based on the 2006 water balance calculations performed as part of this investigation, an estimated 75 percent of the total volume of water used in the tailing disposal operation is unaccounted for. Approximately 775 gpm of the 3,290 gpm used in the tailing disposal operation are accounted for and include the following: consumptive loss (evaporation and retained moisture in tailing) of 500 gpm; discharge of 200 gpm to Outfall 002 (estimated portion of discharge to be tailing seepage); and 75 gpm from the pumpback system (estimated portion of tailing seepage that is returned to the tailing impoundment). An operational water balance for calendar year 2006 shows that on average approximately 3,290 gpm (7.3 cfs) of water was delivered to the tailing facility. Of this amount approximately 500 gpm (1.1 cfs) either evaporated or was retained as moisture in the tailing leaving approximately 2,790 gpm (6.2 cfs) available as total seepage. The seepage interception and pumpback systems collected approximately 550 gpm (1.2 cfs) of water that is comprised of approximately half tailing seepage collected from the Dam No. 1 and Dam No. 4 impoundments and half native groundwater. Of the 550 gpm, 150 gpm are returned to the Dam No. 5A tailing impoundment and 400 gpm are discharged to the Red River at Outfall 002 under CMI's NPDES permit. The 150 gpm returned to Dam No. 5A are available for seepage through the impoundment to the underlying aquifer. The 400 gpm are approximately half tailing seepage, thus about 200 gpm are considered captured tailing seepage. Approximately 2,740 gpm (6.1 cfs) of the total seepage are uncollected and able to migrate from the impoundments to groundwater.

ES 3.2.3 Aquatic Media

The aquatic media evaluated in the Red River along the tailing facility (from the confluence with Cabresto Creek in Questa to the fish hatchery) includes surface water, sediment, and aquatic biota. Sources of constituents along the tailing facility are anthropogenic or mine-related. Anthropogenic or man-made sources include urban areas (e.g., streets and highways) and farmlands in and around Questa, septic tanks, and the Questa Waste Water Treatment Plant.

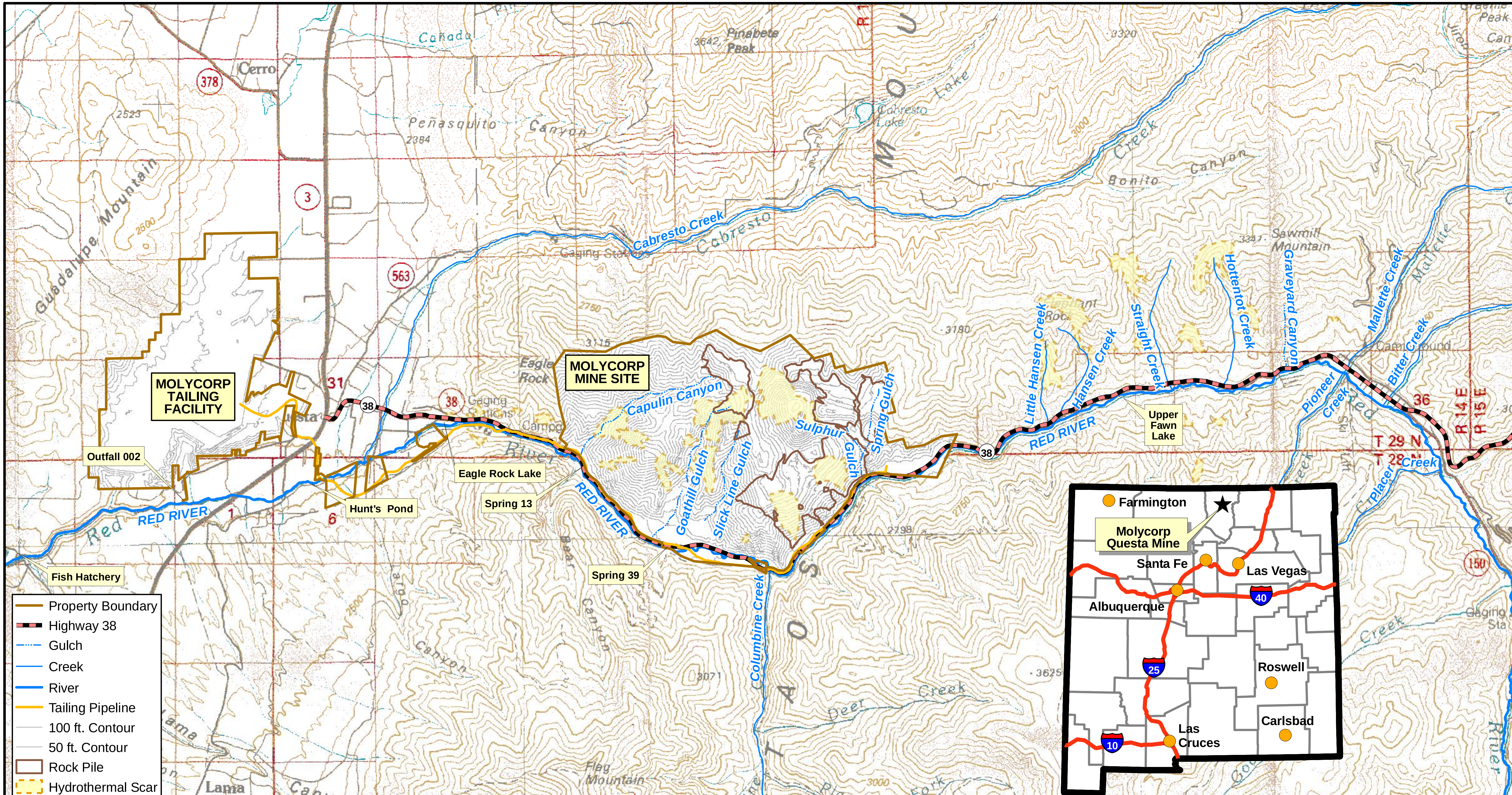
Executive Summary

Mine-related sources include tailing-affected groundwater that upwells into the river and Outfall 002. Outfall 002 (Sites LR-8A and LR-16) discharges intercepted groundwater and seepage to Red River. It is in exposure area EEA-7 and is located adjacent to a grazed pasture along the Red River downstream of Questa. Further below Outfall 002 (EEA-8), the Red River enters a steep canyon, and eventually flows by the fish hatchery.

All surface water chemicals of potential concern that exceed ecological criteria in the Red River along the tailing facility, are also exceeded in a reference reach upstream of the mine. Total aluminum is the only ecological COPC that exceeds water quality acute criteria. Total aluminum and dissolved barium, boron, and cadmium exceeded the chronic criteria.

In the ecological exposure area stretching from Cabresto Creek to just above Outfall 002 (EEA-7), no surface water COPCs are significantly greater than the reference concentrations directly upstream. However, nine sediment COPCs (arsenic, barium, boron, chromium, iron, lead, molybdenum, silver, and thallium) are greater than in the reference reach.

Most aquatic biological data indicated that the tailing exposure reach (EEA-8) was as healthy or healthier than the tailing reference reach (EEA-7). The most significant difference observed between the two was that the tailing exposure reach had higher invertebrate and fish population parameters than the tailing reference reach.



N

5,000 0 Feet

Scale 1:60000 or 1 in = 5000 ft

107707

NOTES
1. Base topography taken from USGS 15 - minute quadrangle for Wheeler Peak, New Mexico (1982). 50 ft Contour Interval

REVISION	DATE
Revision 1	11/10/08

URS

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APPLICATION
ArcGIS 8.3

ri_inv_area.mxd

DRAWN BY
Denver/GIS

10/20/2008

MOLYCORP - QUESTA MINE RI/FS

MOLYCORP REMEDIAL INVESTIGATION AREA

PROJECT
22236246

FIGURE ES-1

Remedial Investigation Report

Table ES-1

SUMMARY OF SOURCES AND POTENTIALLY AFFECTED MEDIA

Mine Site/Tailing Facility Sources/Potential Sources	Exposure Areas*	Chemical Groups Associated with Potential Source[1]	Media Investigated	Media in which 1 or more COPC Concentrations in Exposure Area were Greater than Reference[2, 3]	Report Section Addressing Nature and Extent
Mine Site					
Open Pit Soils	EA4	Metals and Other Inorganics	Soil	Soil	4.1.5, 4.5.4
Subsidence Area	EA4	Metals and Other Inorganics	Not Investigated	Not Investigated	4.1.6
Mill Area/Miscellaneous Independent Sources					
Milling Area (Grinding, Flotation, Thickeners, Drying, Packaging, Chemical Storage)	EA2	VOCs, SVOCs, Metals, and Other Inorganics	Soil and Groundwater	Soil and Groundwater	4.1.1, 4.5.2
Former Drum Storage	EA2	VOCs, SVOCs, Metals, and Other Inorganics	Soil	Soil	4.1.1, 4.5.2
Power Plant	EA2	VOCs, SVOCs, Metals, and Other Inorganics	Soil	Soil	4.1.1, 4.5.2
Existing Vehicle Maintenance Shop	EA2	VOCs, SVOCs, Metals, and Other Inorganics	Soil	Soil	4.1.1, 4.5.2
Bone Yard	EA2	VOCs, SVOCs, Metals, and Other Inorganics	Soil	Soil	4.1.1, 4.5.2
Crushers	EA2	Metals, and Other Inorganics	Soil	Soil	4.1.1, 4.5.2
Fuel/Solvent Storage/Usage	EA2	VOCs, SVOCs, Metals, and Other Inorganics	Soil	Soil	4.1.1, 4.5.2
Mine Site Tailing	EA1	Metals and Other Inorganics	Tailing Material	Not Compared to Reference	4.4.1, 4.5.1
Admin. and M&E//Miscellaneous Independent Sources					
M&E Shop (including Maintenance Area)	EA1	VOCs, SVOCs, Metals, and Other Inorganics	Soil and Groundwater	Soil and Groundwater	4.1.2, 4.4.2, 4.5.1
Explosives Storage	EA1	VOCs, SVOCs, Explosives, Metals, and Other Inorganics	Soil	Soil	4.1.2, 4.5.1
Fuel/Solvent Storage/Usage	EA1	VOCs, SVOCs, Metals, and Other Inorganics	Soil	Soil	4.1.2, 4.5.1
Miscellaneous Independent Sources					
Fuel Storage Areas/Usage	EA3	SVOCs, VOCs at one site	Soil and Groundwater	Soil and Groundwater	4.4.5, 4.5.3
Historic Fueling Area	EA3	SVOCs	Soil	Soil	4.1.9, 4.5.3
Transformers	EA1/EA2/EA3/EA4	PCBs	Soil	Soil	4.1.9, 4.5.1, 4.5.2, 4.5.3, 4.5.4
Core Shack/Former Carpenter Shop	EA3	VOCs, SVOCs, Metals, and Other Inorganics	Soil and Groundwater	Soil and Groundwater	4.1.9, 4.4.5, 4.5.3
Explosive Storage Area	EA3/EA4	SVOCs, Explosives	Soil and Groundwater	Soil and Groundwater	4.1.9, 4.4.5, 4.5.3, 4.5.4
Former Truck Shop Area	EA4	VOCs, SVOCs, Metals, and Other Inorganics	Soil	Soil	4.1.9, 4.5.4
Rock Piles					
Capulin	EA4	Metals and Other Inorganics	Soil, Small Mammals[4] and Groundwater	Soil and Colluvial Groundwater Potential Red River Alluvial Groundwater	4.1.3, 4.2, 4.4.2, 4.4.5, 4.5.4, 4.7.3
Goathill North	EA4	Metals and Other Inorganics	Soil and Groundwater	Soil and Colluvial Groundwater Potential Red River Alluvial Groundwater	4.1.3, 4.2, 4.4.2, 4.4.3, 4.4.5, 4.5.4
Goathill South	EA4	Metals and Other Inorganics	Soil	Soil	4.1.3, 4.2, 4.5.4
Sugar Shack West	EA3	Metals and Other Inorganics	Soil and Groundwater	Soil, Colluvial Groundwater, Bedrock Groundwater and Possibly Red River Alluvial Groundwater	4.1.3, 4.2, 4.4.1, 4.4.2, 4.4.3, 4.4.5, 4.5.4
Sugar Shack South	EA3	Metals and Other Inorganics	Soil and Groundwater	Soil, Colluvial Groundwater, Bedrock Groundwater and Red River Alluvial Groundwater	4.1.3, 4.2, 4.4.1, 4.4.2, 4.4.3, 4.4.5, 4.5.4
Middle	EA3	Metals and Other Inorganics	Soil and Groundwater	Soil, Colluvial Groundwater, Bedrock Groundwater and Red River Alluvial Groundwater	4.1.3, 4.2, 4.4.1, 4.4.2, 4.4.3, 4.4.5, 4.5.4

Table ES-1

SUMMARY OF SOURCES AND POTENTIALLY AFFECTED MEDIA

Mine Site/Tailing Facility Sources/Potential Sources	Exposure Areas*	Chemical Groups Associated with Potential Source[1]	Media Investigated	Media in which 1 or more COPC Concentrations in Exposure Area were Greater than Reference[2, 3]	Report Section Addressing Nature and Extent
Sulphur Gulch South	EA3	Metals and Other Inorganics	Soil and Groundwater	Soil, Colluvial Groundwater, Bedrock Groundwater and Red River Alluvial Groundwater	4.1.3, 4.2, 4.4.1, 4.4.2, 4.4.3, 4.4.5, 4.5.4
Spring Gulch	EA3	Metals and Other Inorganics	Soil and Groundwater	Soil, Colluvial Groundwater, Bedrock Groundwater and Red River Alluvial Groundwater	4.1.3, 4.2, 4.4.1, 4.4.2, 4.4.3, 4.4.5, 4.5.4
Sulphur Gulch North/Blind Gulch	EA3	Metals and Other Inorganics	Soil and Groundwater	Soil, Colluvial Groundwater, Bedrock Groundwater and Red River Alluvial Groundwater	4.1.3, 4.2, 4.4.1, 4.4.2, 4.4.3, 4.4.5, 4.5.4
Historic and Current Spring Gulch Landfills, Former Goathill Landfill and Underground Debris Stockpile	EA3/EA4	VOCs, SVOCs, Metals, and Other Inorganics	Soil and Groundwater	Soil and Groundwater	4.1.9, 4.4.5, 4.5.3
Goathill Gate Gas/Diesel USTs and Other Current Non-gasoline USTs	EA1, EA3, EA4	TPH (DRO, GRO), VOCs, PAHs	Soil	Soil	2.10.5, 4.1.2, 4.5.4
USTs – Sources Removed	EA3	VOCs, PAHs	Soil	Soil	2.10.5
Tailing Pipeline	EA5/EA6	Metals and Other Inorganics	Tailing and Soil	Soil	4.1.7, 5.1.2, 6.1.1, 6.1.3
Tailing Pipeline Emergency Sumps	EA5/EA6	Metals and Other Inorganics	Soil and Groundwater	Groundwater (US – Nitrite Only, LS – Arsenic and Molybdenum Only)	4.1.7, 4.4.1, 4.4.5, 5.1.2, 6.1.1, 6.1.3
Naturally Occurring Mine Site Scars (Hydrothermal Scar)	EA3/EA4	Metals and Other Inorganics	Soil, Animals, Surface Water, Sediment, and Groundwater	Soil, Colluvial Groundwater, Bedrock Groundwater and Red River Alluvial Groundwater, Surface Water, Sediment	4.1.8, 4.2.3, 4.4.1, 4.4.2, 4.4.3, 4.4.5, 6.4.5
Secondary Sources					
Other Mine Site Soils	EA4	Metals and Other Inorganics	Soil, Vegetation, Animals and Groundwater	Soil, Red River Alluvial Groundwater, Colluvial Groundwater, Bedrock Groundwater, Vegetation[5]	4.1.3, 4.2, 4.4.5, 4.5.4, 4.6.5
Riparian Soils	EA5/EA6	Metals and Other Inorganics	Soil, Vegetation and Animals	Soil, Vegetation and Animals[6]	6.1.1, 6.1.3, 6.2.3, 6.3.3
Tailing Facility					
Dry/Maintenance Area	EA7	Metals and Other Inorganics, VOCs and SVOCs in Groundwater	Soil and Groundwater	Soil, Upper Alluvial Groundwater (Molybdenum Only)	5.1.3, 5.4.1, 5.5.1, 5.5.6
IX Plant	EA7	Metals and Other Inorganics	Soil	Soil	5.1.4, 5.4.1
Pope Lake	EA7	Metals and Other Inorganics	Soil	Soil	5.1.5, 5.4.1
Tailing Impoundments	EA7	Metals and Other Inorganics	Soil, Sediment and Surface Water[7]	Subsurface Soil, Upper Alluvial Groundwater, Basal Bedrock Groundwater	5.1.1, 5.4.1, 5.5

Table ES-1

SUMMARY OF SOURCES AND POTENTIALLY AFFECTED MEDIA

Mine Site/Tailing Facility Sources/Potential Sources	Exposure Areas*	Chemical Groups Associated with Potential Source[1]	Media Investigated	Media in which 1 or more COPC Concentrations in Exposure Area were Greater than Reference[2, 3]	Report Section Addressing Nature and Extent
Pipeline Water	EA6	Metals and Other Inorganics	Soil	None	5.1.2, 6.1.1, 6.1.3
Secondary Sources South Downgradient of Tailing Impoundment – Resuspended Particulates, Groundwater, Soil, Air	EA7, EA8, EA9	Metals and Other Inorganics	Soil, Air, Groundwater, Vegetation, Animals (only EA7)	Upper Alluvial Groundwater (Limited to Molybdenum, Sulfate and Manganese), Basal Bedrock Groundwater (Limited to Molybdenum), Vegetation and Animals	2.10.4, 5.4.2, 5.5.1, 5.5.3, 5.5.6, 5.6.3, 6.1.4, 6.1.5, 6.2.3

Notes:

[1] Chemical groups

DRO	=	diesel range organics
GRO	=	gasoline range organics
LS	=	lower dump sump wells
PAH	=	polynuclear aromatic hydrocarbon
PCB	=	polychlorinated biphenyls
SVOC	=	semi-volatile organic compounds
TPH	=	total petroleum hydrocarbons
US	=	upper dump sump wells
UST	=	underground storage tank
VOC	=	volatile organic compounds

[2] Reference comparisons were conducted in accordance with the procedure in the Statistics Usage Methodologies Technical Memorandum (URS 2006). For organics, a criterion of greater than 5% detection was used.

[3] Red River surface water, sediment and aquatic biota were identified as exposure media potentially affected by mine site or tailing facility sources. The transport mechanism is from multiple sources to groundwater, to surface water, to sediment and aquatic biota. However, contribution from specific sources cannot be distinguished. Natural scars in drainages upstream of the mine are also sources of contaminants to the Red River.

[4] Small mammals were collected from the toes of Capulin Rock Pile to represent all rock piles. They were not compared to a reference area statistically.

[5] For vegetation, if any constituent concentration in any of the three plant varieties sampled for either above ground or below ground material exceeds reference, then "Vegetation" is listed.

[6] For animals, if any COPC concentration for small mammals or earthworms exceeds reference, then "Animals" is listed. Earthworms are laboratory test earthworms grown on site soils.

[7] Impoundment sediment and surface water were investigated but not compared to reference. See Section 5.2 for nature and extent.

*EPA Soil Exposure Areas in HHRA and BERA

Bold = Sources or potential sources as identified in the RI/FS Work Plan Conceptual Site Model.

Table ES-2

SUMMARY OF CHEMICALS OF POTENTIAL CONCERN FOR MINE SITE AND TAILING FACILITY MEDIA

Inorganic Constituents	Mine Site							Tailing Facility						
	GW	SW		SED		SOIL		GW	SW		SED		SOIL	
	HH	HH	E	HH	E	HH	E	HH	HH	E	HH	E	HH	E
Aluminum	X	X	X	–	X	–	X	X	–	X	–	–	–	–
Antimony	X	–	–	–	–	–	X	–	–	–	–	–	–	X
Arsenic	X	X	–	X	X	X	X	X	–	–	X	X	X	–
Barium	–	–	X	–	X	–	X	–	–	X	–	X	–	X
Beryllium	X	X	X	–	X	–	–	–	–	–	–	X	–	–
Boron	–	–	X	–	X	–	X	–	–	X	–	X	–	X
Cadmium	X	X	X	–	X	–	X	–	–	X	–	X	–	X
Chromium, total	X	X	X	–	–	–	X	X	–	–	–	X	–	X
Chromium, hexavalent	–	–	X	–	–	–	–	–	–	–	–	–	–	–
Cobalt	X	X	X	–	X	–	X	–	–	–	–	–	–	–
Copper	X	X	X	–	X	–	X	–	–	–	–	X	–	X
Fluoride	X	X	–	–	–	–	–	–	X	–	–	–	–	–
Iron	X	X	X	X	X	X	X	X	–	–	X	X	X	X
Lead	X	X	X	–	X	X	X	X	–	–	–	X	–	X
Manganese	X	X	X	X	X	–	X	X	X	X	–	X	–	X
Mercury	–	–	–	–	X	–	X	–	–	–	–	–	–	X
Molybdenum	X	X	X	–	X	X	X	X	X	X	X	X	X	X
Nickel	X	X	X	–	X	–	X	–	–	X	–	X	–	–
Nitrite	X	–	–	–	–	–	–	–	–	–	–	–	–	–
Selenium	–	X	X	–	X	–	X	–	–	–	–	X	–	X
Silver	–	–	–	–	X	–	X	–	–	X	–	X	–	–
Sulfate	X	X	–	–	–	–	–	–	X	–	–	–	–	–
Thallium	–	X	–	–	X	–	X	–	–	–	–	X	–	–
Uranium	–	–	–	–	–	–	–	X	–	–	–	–	–	–
Vanadium	X	X	X	–	–	X	X	X	–	–	–	–	–	X
Zinc	X	X	X	–	X	–	X	–	–	X	–	X	–	X
Total Inorganic COPCs	**18**	**18**	**17**	**3**	**18**	**5**	**20**	**9**	**4**	**9**	**3**	**16**	**3**	**14**

Table ES-2

SUMMARY OF CHEMICALS OF POTENTIAL CONCERN FOR MINE SITE AND TAILING FACILITY MEDIA

Organic Constituents	Mine Site							Tailing Facility						
	GW	SW		SED		SOIL		GW	SW		SED		SOIL	
	HH	HH	E	HH	E	HH	E	HH	HH	E	HH	E	HH	E
2,4,6-Trinitrotoluene *	X	–	–	–	–	–	–	–	–	–	–	–	–	–
2,6-Dinitrotoluene *	–	–	–	–	–	–	X	–	–	–	–	–	–	–
Aroclor 1248	–	–	–	–	–	X	X	–	–	–	–	–	–	–
Aroclor 1254	–	–	–	–	–	X	X	–	–	–	–	–	–	–
Aroclor 1260	–	–	–	–	–	X	–	–	–	–	–	–	–	–
Benzo(a) anthracene	–	–	–	–	–	X	–	–	–	–	–	–	–	–
Benzo(a) pyrene	–	–	–	–	–	X	–	–	–	–	–	–	X	–
Benzo(b) fluoranthene	–	–	–	–	–	X	–	–	–	–	–	–	–	–
Carbazole	–	–	–	–	–	–	–	–	–	–	–	–	–	X
Dibenz(a,h) anthracene	–	–	–	–	–	X	–	–	–	–	–	–	–	–
Diesel Fuel No. 2	–	–	–	–	–	–	–	–	X	X	–	–	–	–
Gasoline	–	–	–	–	–	–	–	–	X	X	–	–	–	–
Phenanthrene	–	–	–	–	–	–	X	–	–	–	–	–	–	–
Total Organic COPCs	**1**	**0**	**0**	**0**	**0**	**7**	**4**	**0**	**2**	**2**	**0**	**0**	**1**	**1**

Notes:
* Retained even though frequency of detection is less than 5 percent.

–	=	Not a chemical of potential concern for this medium and receptor
COPC	=	chemical of potential concern
E	=	ecological
GW	=	ground water
HH	=	human health
SED	=	sediment
SW	=	surface water
X	=	chemical of potential concern for this medium and receptor

Table is modified from Tables 2-1 and 2-2 in the Final Risk Assessment Memorandum, prepared by EPA (CDM 2007a)

SECTIONONE Introduction

List of Figures

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SECTIONONE Introduction

Molycorp, Inc. (Molycorp[1]) entered into an Administrative Order on Consent (AOC) with the U.S. Environmental Protection Agency (EPA) to perform a Remedial Investigation/Feasibility Study (RI/FS) under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) for the Molycorp Site (hereinafter the "Site") in Taos County, New Mexico. Molycorp is the owner and operator of a molybdenum mine and associated facilities located approximately 3.5 miles east of the village of Questa, New Mexico. As part of the operations, Molycorp owns a tailing pipeline that generally runs parallel to State Highway 38, and a tailing facility located west of the village of Questa. Figure 1-1 shows the general location of the Site, including the mine site, tailing facility, and pipeline. These mining, milling, and tailing disposal features and operations comprise the Site, and tailing facility features, as well as all other areas where any hazardous substance, pollutant, or contaminant (hereinafter "contaminant") from mining, milling, and tailing disposal operations has come to be located.

To date, the Molycorp mine property has had three phases of mine development. From 1919 to 1958 mining was conducted by conventional underground methods. The second phase of mining, or open pit period, occurred between 1964 and 1983. During open pit mining, overburden associated with mining (hereinafter 'waste rock') was dumped into ten piles in drainages north of the Red River and adjacent to the open pit. In this RI Report, the terms 'mine rock' and 'mine rock piles' refer to 'waste rock' and 'waste rock piles.' Beginning in 1965, tailing dams were constructed near the village of Questa along with a 9-mile long tailing pipeline to transport tailing from the mill to the tailing impoundment area. In 1983, the third and current phase of mining began, returning to underground mining using block-caving techniques. A subsidence area has formed over the initial caving block under Goathill Gulch. The key operational features of the mine site and tailing facility areas are shown on aerial photographs in Figures 1-2 and 1-3, respectively.

The objectives of the RI/FS for the Molycorp mine as defined in the AOC are as follows:

- To determine the nature and extent of contamination and any threat to the public health, welfare, or the environment caused by the release or threatened release of hazardous substances, pollutants, or contaminants (hereinafter "contaminants") at or from the Site, by conducting a RI.
- To determine and evaluate alternatives for remedial action to prevent, mitigate, or otherwise respond to or remedy any release or threatened release of contaminants at or from the Site or facility, by conducting a FS.

The RI/FS process includes three components: the RI, the risk assessment, and the FS. This report is the RI component which serves to present the nature and extent of contamination at the Site. Data collected during the RI also are used in the risk assessment and the FS. The risk assessment, which addresses the threat to the public health, welfare, or the environment, is being prepared by EPA. The FS will evaluate alternatives for remedial action based on the risk assessment and is in progress.

[1] Molycorp, Inc. became Chevron Mining Inc. (CMI) in 2007 through corporate merger.

The sampling and analysis conducted for the RI was performed under EPA oversight in accordance with the Final Molycorp Remedial Investigation/Feasibility Study Work Plan (Work Plan), with modifications approved or prepared by EPA. The RI/FS Work Plan consists of the following documents:

- Final Molycorp RI/FS Work Plan (URS 2007a)
- Final Molycorp RI/FS Quality Assurance Project Plan (QAPP) (URS 2007b)
- Final Molycorp RI/FS QAPP, Appendix A Field Sampling Plan (URS 2007c)
- Final Molycorp RI/FS QAPP, Appendix B Standard Operating Procedures (URS 2007d)
- Final Molycorp RI/FS Health and Safety Plan (URS 2007e)
- Final Molycorp RI/FS QAPP, Appendix A Field Sampling Plan, Automatic Samplers on the Red River, Addendum One (URS 2007f)
- Final Molycorp RI/FS QAPP, Appendix A Field Sampling Plan, Appendix A1: Sampling and Analysis Plan for Investigating Historical Tailings [sic] Spill Deposits (URS 2007g)
- Final Molycorp RI/FS QAPP, Appendix A Field Sampling Plan, Rock Pile Characterization Work Plan, Addendum 2 (URS 2007h)
- Final RI/FS Work Plan Addendum, Additional Data Collection to Determine Environmental Impacts of Ground Water Discharge to the Red River (EPA 2004a)

During meetings between Molycorp, EPA, and NMED, several additional investigations were developed and scoped for the RI. This additional work performed for the RI is noted in the report and the investigations were conducted in accordance with the RI protocols.

The Molycorp mine is an active mining operation with operational permits and operates in compliance with these permits and associated state and federal regulations. During the RI field studies, some of the operational permit requirements overlapped with RI activities. Any information which was collected for a purpose other than the RI is described and the purpose documented in this report. Previous investigations and Site history are included in the Work Plan (URS 2007a).

During scoping of the RI/FS, it was recognized by EPA that a significant amount of historic environmental data had previously been collected at the Site. Rather than being overly redundant, EPA decided to have those historical data incorporated into the RI/FS, to the extent practicable, as long as they met the quality assurance and quality control (QA/QC) requirements set forth in the approved RI/FS QA Project Plans. An extensive review of the Site-related historical documents was conducted. Those documents which were found acceptable and incorporated into the RI/FS are identified in Table 1 of Appendix 2.10-2.

The RI report is organized into the following sections:

Section 1 Introduction

Section 2 Site Investigation

Section 3 Physical Characteristics

Section 4 Nature and Extent of Contamination at the Mine Site

Section 5 Nature and Extent of Contamination at the Tailing Facility

Section 6 Nature and Extent of Contamination In Red River and Riparian Areas

Section 7 Fate and Transport

Section 8 Conclusions

Section 9 References

Section 2 describes the Site Investigation performed to characterize potential contaminant sources in the mine site and tailing facility areas, the presence or absence of chemicals of potential concern (COPCs) in the potentially impacted media, and if present, the nature and extent of COPCs in these media. In accordance with the Statement of Work (SOW; Attachment A to the AOC), all potential sources (including man-made and natural sources) of contamination on and near the Site were investigated, including drums, tanks, surface impoundments, tailing (including historic tailing spills), waste rock piles, landfills, hydrothermal scars, and media. All media were investigated and this includes air, soil, surface water, sediments, groundwater, terrestrial biota (vegetation and animals), and aquatic biota. As part of the required effort to define sources of contamination at the Site, a characterization study of the mine site roadside waste rock piles (i.e., Sugar Shack South, Middle, and Sulphur Gulch waste rock piles) was performed to assess this area as a potential source whether those piles are (1) sources of contamination and (2) similar or different to all the other waste rock piles at the mine site, as potential sources. This characterization study was used, along with historical data, to evaluate all the rock piles at the mine site as potential sources of contamination to ground water (and surface water at zones of ground-water upwelling). It is noted that EPA originally planned to use historic data for characterization of all the waste rock piles. However, the decision to perform this additional characterization was made when drill cuttings from boreholes installed into the roadside waste rock piles as part of the Norwest Corporation's stability investigation became available. Additionally, geophysical investigations were conducted at the mine site and tailing facility to characterize subsurface conditions influencing groundwater flow. Other related studies were conducted, some under the direction of other regulatory authorities, concurrent with the RI, and have been incorporated into or support the RI. Their scope of work is briefly summarized in Section 2 with reference to the specific documents. The other studies include a Wildlife Impact Study, a historic tailing spill investigation, EPA's focused studies (including groundwater/surface water interaction [GSI] studies), air quality monitoring, and fuel storage tank investigations.

Section 3 presents the results of the field activities conducted to determine physical characteristics of the mine site and tailing facility. Additional non-RI data and literature sources also were used in the discussion of physical characteristics. The topics discussed in this section include surface soils, meteorology, surface water hydrology, regional geology, hydrogeology, terrestrial ecology, and aquatic ecology.

Sections 4 through 6 provide information on the nature and extent of contamination for the Site. Section 4 presents the nature and extent of contamination for mine site media. First, the potential sources (natural and mine-related) at the mine site are discussed. The mine rock piles are evaluated as a potential source using a geochemical study. The media potentially affected by these sources are then discussed including catchment water, groundwater, surface soil, and terrestrial vegetation and animals. The extent of potential contamination is evaluated by comparing concentrations to screening level criteria (SLC) (if available) and by statistically comparing the concentrations of an exposure area to the reference area.

Section 5 presents nature and extent of contamination for media at the tailing facility. First, the potential sources at the tailing facility are discussed. The media potentially affected by the sources are then discussed including surface water, sediment, aquatic biota in the tailing impoundments, surface soil, groundwater, terrestrial vegetation, terrestrial animals, and air. Similar to the mine site, the extent of potential contamination at the tailing facility is evaluated by comparing concentrations to SLC (if available) and by statistically comparing the concentrations in the media exposure areas to the reference area.

Section 6 presents nature and extent of contamination for media associated with Red River (surface water, sediment, and aquatic biota) and riparian areas (soil and terrestrial vegetation/animals). Similar to the mine site and tailing facility, the extent of potential contamination in Red River and riparian areas is evaluated by comparing concentrations to SLC (if available) and by statistically comparing the concentrations in the media exposure areas to the reference area. Also, a summary of the GSI studies performed by EPA are presented.

Section 7 provides the results of modeling and analyses to better understand the fate and transport of constituents potentially migrating from the mine to Red River. The modeling and analyses include inverse geochemical mixing, Principal Components Analysis (PCA), and groundwater loading calculations.

Section 8 presents the overall conclusions for the RI. For the media that are interrelated, the conclusions are presented together to provide the various lines of evidence among the different media for a given exposure area. Conclusions for soil and terrestrial vegetation/animals are discussed together, as are surface water, sediment, and aquatic biota in Red River.

Interpretations and evaluations presented in this RI Report are based on Site data collected through June 2006, as agreed upon by EPA and NMED. Since June 2006, additional data have been collected at the Site. Groundwater sampling under the Mine's discharge permits has continued quarterly. Two new monitoring wells were installed east of the tailing facility in March 2008 at the request of the village of Questa, under a work plan approved by EPA and NMED. Also, additional operational data were collected. To provide a more current representation of Site conditions, these additional data were added to the RI Report in the following appendices:

- Appendix 1.0-1 Results of Additional Data Collected at the Mine Site
- Appendix 1.0-2 Results of Additional Data Collected at the Tailing Facility
- Appendix 1.0-3 2006 Operational Water Balance for the Tailing Facility

Appendix 1.0-1 includes water level elevation maps and isoconcentration maps for key mine constituents, groundwater concentration versus time series graphs, and statistical trend analyses of groundwater concentrations using data collected through June 2008. Appendix 1.0-2 provides a well completion report for the two new wells installed east of the tailing facility and an analytical summary report for the two new wells. Also provided in Appendix 1.0-2 are a cross section, a contour map of clay thickness, water level elevation maps, isoconcentrations maps for key tailing facility constituents, groundwater concentration versus time series graphs, piper diagrams, and statistical trend analyses of groundwater concentrations using information from the new wells and updated sampling data through June 2008. Appendix 1.0-3 presents an updated water balance evaluation and discussion for the tailing facility. In the RI Report, observations based on data collected through 2006 are consistent with and supported by the new data collected from June 2006 through June 2008, except in a few instances. In these instances, the differences were noted in the text of the RI Report.

Section 1
Appendices

List of Section 1 Appendices

- Appendix 1.0-1 Results of Additional Data Collected at the Mine Site
- Appendix 1.0-2 Results of Additional Data Collected at the Tailing Facility
- Appendix 1.0-3 2006 Operational Water Balance for the Tailing Facility

Appendix 1.0-1

Results of Additional Data Collected at the Mine Site

Appendix 1.0-1

Results of Additional Data Collected at the Mine Site

List of Attachments

- Attachment A — Water Level Maps for the Mine Site
- Attachment B — Concentration Maps for Wells at the Mine Site
- Attachment C — Time Series Graphs for Select Constituents for Mine Site and Reference Wells and Seeps/Springs
- Attachment D — Statistical Trend Analysis Methodology for the Cabin Springs, Mine Site, and Tailing Area

Attachment A

Water Level Maps for the Mine Site